Introducing urban street configuration for improvements in air pollution land use regression models, using 3D building data

Authors: Marloes Eeftens[1], Johan Beekhuizen[1], Rob Beelen[1], Roel Vermeulen[1], Anke Huss[1], Gerard Hoek[1]

1 IRAS Institute for Risk Assessment Sciences, Utrecht, The Netherlands

Word count: 293

Background and aims

Land use regression (LUR) has become a valuable tool to estimate spatial variability of air pollutants within cities. However, in many urban built-up areas, tall buildings along narrow streets obstruct the free flow of air, resulting in higher pollution levels, which are difficult to predict by current LUR models. We describe an approach to calculate indicators of the urban canyon effect for improvement of spatially resolved LUR models using 3-dimensional building data.

Methods

Concentrations of NO_2 and NO_X were measured at 68 sites in the Netherlands, and LUR models were computed for both components using predictors such as population density, land-use and nearby traffic intensity. We used ArcGis10 and python scripting to calculate two indicators for canyon effects at each site: (1) the maximum aspect ratio (building height/width of the street) between buildings on opposite sides of the street, and (2) the mean building angle, which is the angle between the horizontal street level and the line of sight to the top of the nearest building. For each site, we calculated 360 building angles in 1-degree steps centered horizontally around the site, and these angles were then averaged. We evaluated whether the two indicators added to the explained variance of the LUR models.

Results

Explained variance of the original models was 89% for NO_2 and 83% for NO_X. A higher mean building angle was associated with an increase in NO_2 and NO_X concentration and improved the explained variance of both the NO_2 and NO_X LUR model (to 91% and 85%, respectively). The maximum aspect ratio did not significantly improve the models.

Conclusion

Original LUR models explained large percentages of spatial variability in NO_2 and NO_X. Preliminary results suggest that performance of LUR models can be further improved by taking into account buildings obstructing free air flow.